

turning knowledge into practice

STORET Analytical Tools – Concepts and Cross Program Linkages.

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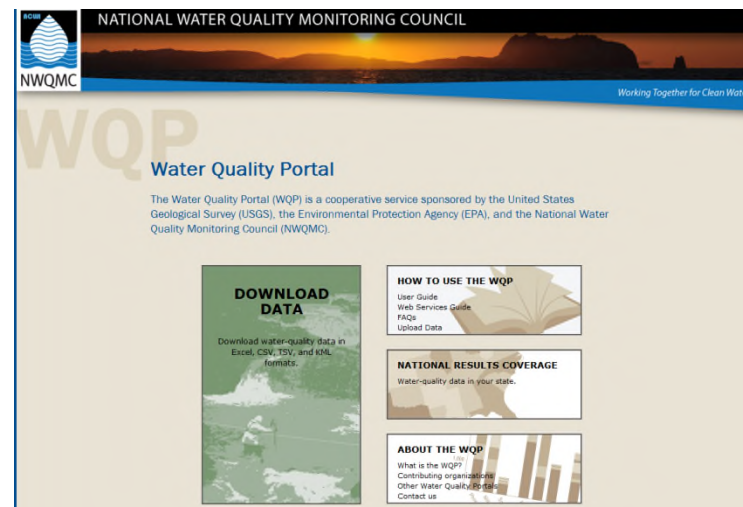
RTI International is a trade name of Research Triangle Institute

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Presentation Outline

- Data Discovery
 - STORET Repository
 - National Water Quality (NWQ) Portal
 - Additional Data Discovery Functions
- Automated Assessment Tools
 - STORET Trends Analysis Tool
 - Seasonal Kendall Trend
 - Clean Water Act Reporting
 - National Level Screening
 - Exploratory Data Analysis (EDA)
 - National Aquatic Resources Surveys (NARS)
 - Statistical Analysis Tools
 - Additional Functions
 - Upstream/Downstream Summarization
 - NHDPlus Catchments
 - Eco-flows Calculation



Data Discovery

STORET and The National Water Quality (NWQ) Portal

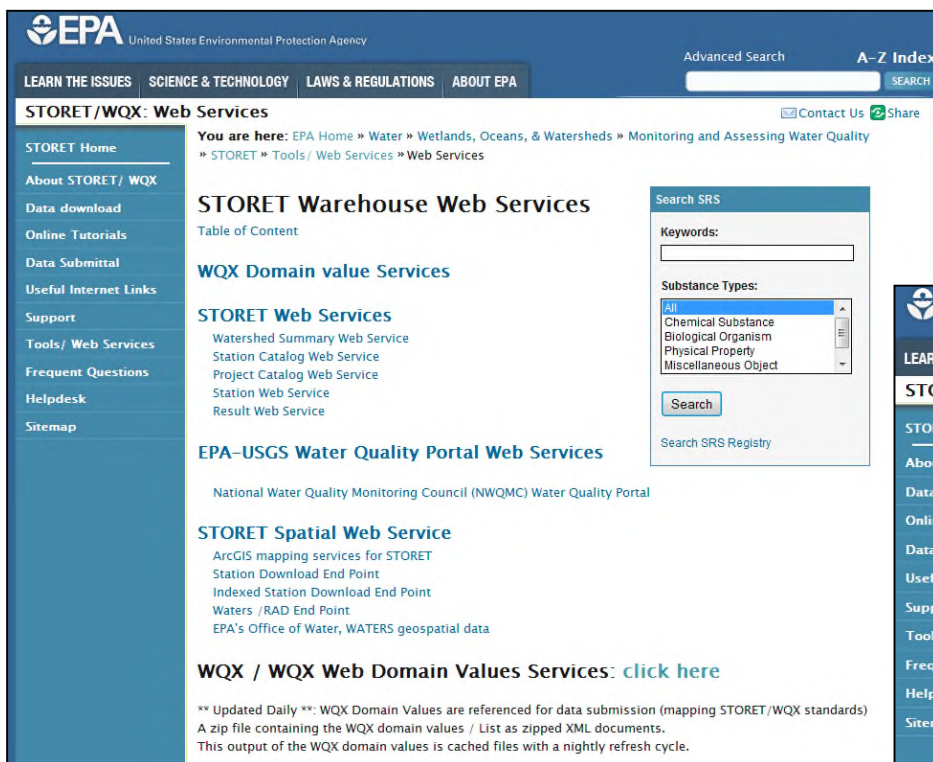
STORET

- STOrage and RETrieval Data Warehouse
<http://www.epa.gov/storet/>
- National repository for water quality monitoring data collected by water resource management groups.

NWQ Portal

- Cooperative service sponsored by USGS, EPA and NWQMC
- Provides access to data stored in large Water quality Databases
 - USGS NWIS
 - STORET

Additional Data Discovery Functions



The screenshot shows the EPA STORET/WQX Web Services page. The header includes the EPA logo and navigation links: LEARN THE ISSUES, SCIENCE & TECHNOLOGY, LAWS & REGULATIONS, and ABOUT EPA. A search bar and an A-Z Index link are also present. The main content area is titled 'STORET/WQX: Web Services' and includes a breadcrumb trail: 'You are here: EPA Home » Water » Wetlands, Oceans, & Watersheds » Monitoring and Assessing Water Quality » STORET » Tools/ Web Services » Web Services'. The page is divided into three main sections: 'STORET Warehouse Web Services' with a 'Table of Content' link, 'WQX Domain value Services', and 'STORET Web Services' which lists various services like 'Watershed Summary Web Service' and 'Station Catalog Web Service'. A 'Search SRS' box is also visible. The left sidebar contains a 'Support' section with links to 'STORET Home', 'About STORET/ WQX', 'Data download', 'Online Tutorials', 'Data Submittal', 'Useful Internet Links', 'Support', 'Tools/ Web Services', 'Frequent Questions', 'Helpdesk', and 'Sitemap'.

STORET Warehouse Web Services
Table of Content

WQX Domain value Services

STORET Web Services
Watershed Summary Web Service
Station Catalog Web Service
Project Catalog Web Service
Station Web Service
Result Web Service

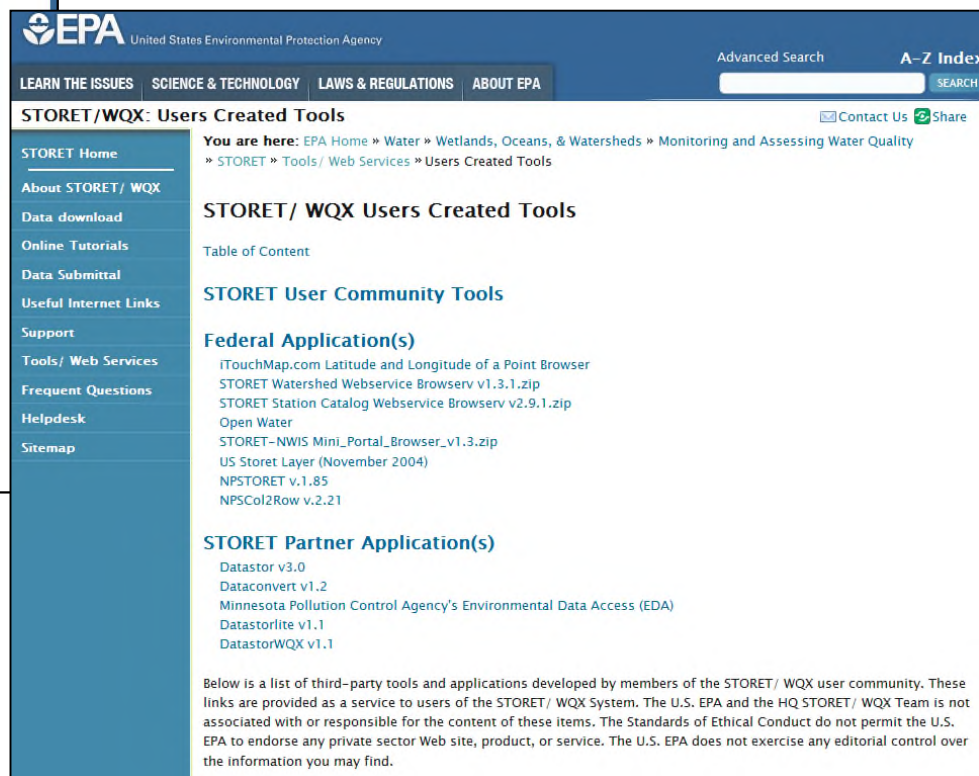
EPA-USGS Water Quality Portal Web Services
National Water Quality Monitoring Council (NWQMC) Water Quality Portal

STORET Spatial Web Service
ArcGIS mapping services for STORET
Station Download End Point
Indexed Station Download End Point
Waters /RAD End Point
EPA's Office of Water, WATERS geospatial data

WQX / WQX Web Domain Values Services: [click here](#)

**** Updated Daily **:** WQX Domain Values are referenced for data submission (mapping STORET/WQX standards)
A zip file containing the WQX domain values / List as zipped XML documents.
This output of the WQX domain values is cached files with a nightly refresh cycle.

<http://www.epa.gov/storet/tools.html>



The screenshot shows the EPA STORET/WQX Users Created Tools page. The header is identical to the previous page. The main content area is titled 'STORET/WQX: Users Created Tools' and includes a breadcrumb trail: 'You are here: EPA Home » Water » Wetlands, Oceans, & Watersheds » Monitoring and Assessing Water Quality » STORET » Tools/ Web Services » Users Created Tools'. The page is divided into three main sections: 'STORET/ WQX Users Created Tools' with a 'Table of Content' link, 'STORET User Community Tools', and 'Federal Application(s)' which lists various applications like 'iTouchMap.com Latitude and Longitude of a Point Browser' and 'STORET Watershed Webservice Browserv v1.3.1.zip'. The left sidebar is identical to the previous page.

STORET/ WQX Users Created Tools
Table of Content

STORET User Community Tools

Federal Application(s)
iTouchMap.com Latitude and Longitude of a Point Browser
STORET Watershed Webservice Browserv v1.3.1.zip
STORET Station Catalog Webservice Browserv v2.9.1.zip
Open Water
STORET-NWIS Mini_Portal_Browser_v1.3.zip
US Storet Layer (November 2004)
NPSTORET v.1.85
NPSCol2Row v.2.21

STORET Partner Application(s)
Datastor v3.0
Dataconvert v1.2
Minnesota Pollution Control Agency's Environmental Data Access (EDA)
Datastorlite v1.1
DatastorWQX v1.1

Below is a list of third-party tools and applications developed by members of the STORET/ WQX user community. These links are provided as a service to users of the STORET/ WQX System. The U.S. EPA and the HQ STORET/ WQX Team is not associated with or responsible for the content of these items. The Standards of Ethical Conduct do not permit the U.S. EPA to endorse any private sector Web site, product, or service. The U.S. EPA does not exercise any editorial control over the information you may find.

Automated Assessment Tools

Automated Assessment Tools


1. STORET Trends Analysis
2. Clean Water Act (CWA) Reporting
3. National Level Screening
4. Exploratory Data Analysis (EDA)
5. National Aquatic Resources Surveys (NARS)
Statistical Analysis

1. STORET Trends Analysis Tool

- Goal: Provide users with the ability to statistically identify trends in STORET Data.
- Pilot was run on a static copy of the STORET database.
 - Conducted a Seasonal Kendall Trend analysis for 22 characteristic types at all STORET stations.
 - Utilized open source “R” for this analysis.

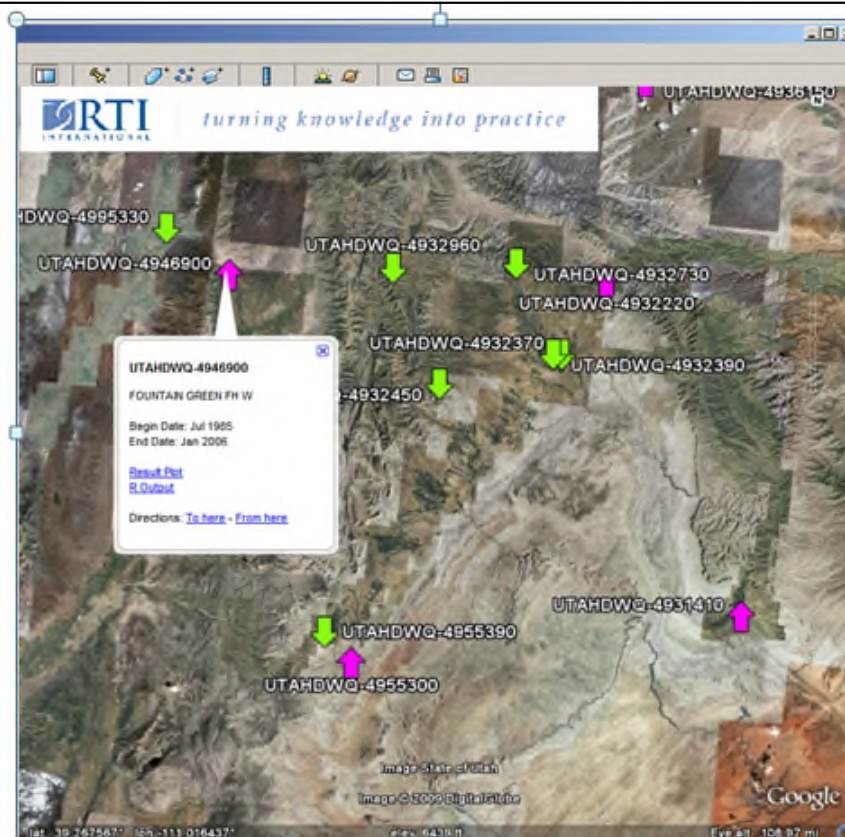
1. STORET Trends Analysis Tool cont.

STORET Characteristics used for the Pilot Study

 **STORET Trends**

Trends for Rivers/Streams

- ☒ Absolute Positioning: Bottom left
- ☐ Arsenic
- ☐ Cadmium
- ☐ Copper
- ☐ Dissolved oxygen (DO)
- ☐ Fecal Coliform
- ☐ Lead
- ☐ Mercury
- ☐ Nitrogen, Kjeldahl
- ☐ Nitrogen, Nitrate (NO3) as NO3
- ☐ Nitrogen, Nitrite (NO2) + Nitrate (NO3) as N
- ☐ Nitrogen, ammonia (NH3) + ammonium (NH4)
- ☐ Nitrogen, ammonia (NH3) as NH3
- ☐ Nitrogen, ammonia as N
- ☐ Nitrogen, mixed forms (NH3)+(NH4)+organic+(NO2)+(NO3)
- ☒ pH
- ☐ Phosphorus
- ☐ Phosphorus as P
- ☐ Phosphorus, orthophosphate as P
- ☐ Solids, Total Suspended (TSS)
- ☐ Temperature, water
- ☐ Turbidity
- ☐ Zinc



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UTAHDWQ-4946900
FOUNTAIN GREEN FH W
Begin Date: Jul 1985
End Date: Jan 2006
[Result Plot](#)
[R.Outout](#)
Directions: [To here](#) - [From here](#)

UTAHDWQ-4995330
UTAHDWQ-4946900
UTAHDWQ-4932960
UTAHDWQ-4932730
UTAHDWQ-4932220
UTAHDWQ-4932370
UTAHDWQ-4932390
UTAHDWQ-4932450
UTAHDWQ-4955390
UTAHDWQ-4955300
UTAHDWQ-4951410

Image State of Utah
Image © 2009 DigitalGlobe
Google

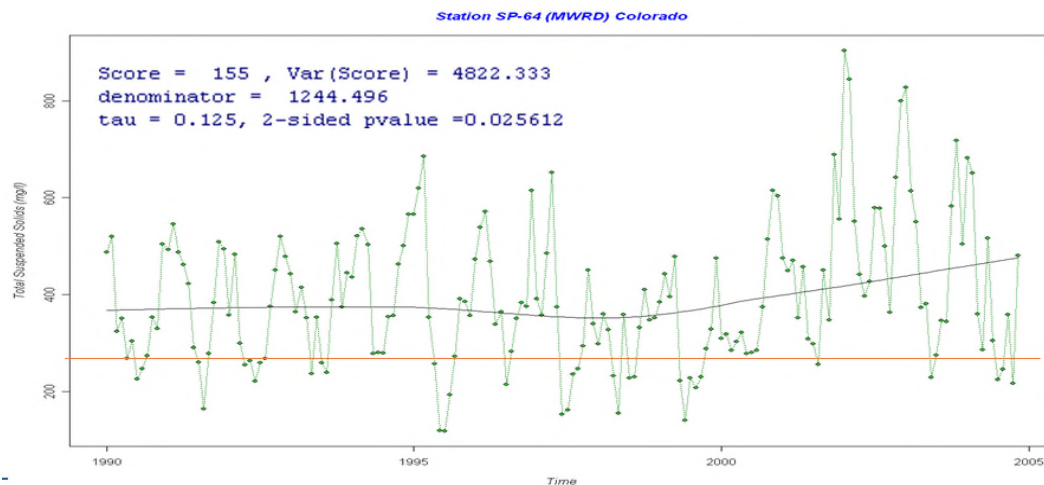
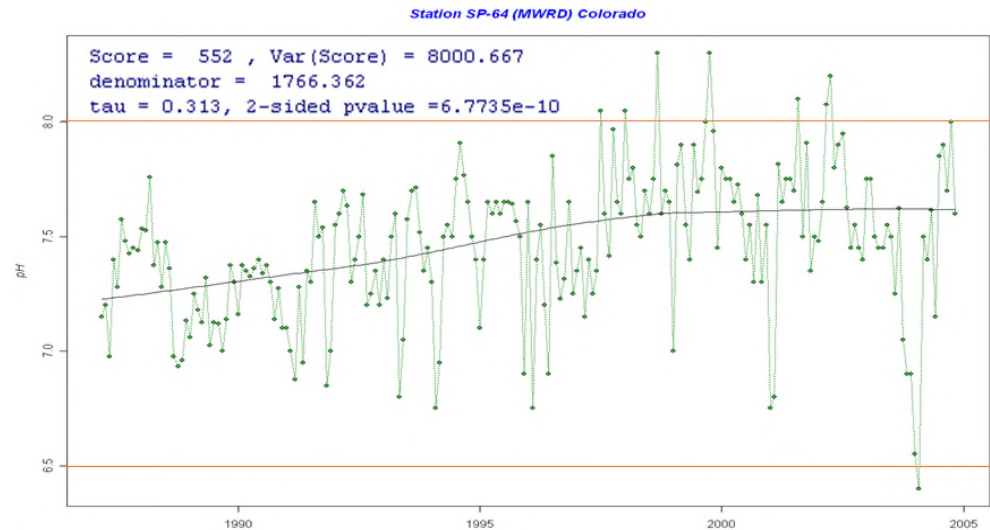
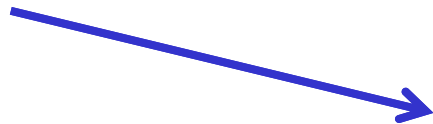
lat: 39.267567° lon: -111.016437° elev: 6430 ft Eye alt: 108.97 mi

1. STORET Trends Analysis Tool cont.

- Stations that did not have an adequate period of records to support a trends analysis were removed.
 - Created a script to filter for stations having a time series with at least four measurements collected periodically for at least five years.
- A minimum of 20 measurements was determined to provide for the investigation of serial correlation (Yue and Wang, 2004)
- Produced trend plots and scores for each parameter.

1. STORET Trends Analysis Tool cont.

Trend Plot for pH produced by the STORET Trends Analysis Tool

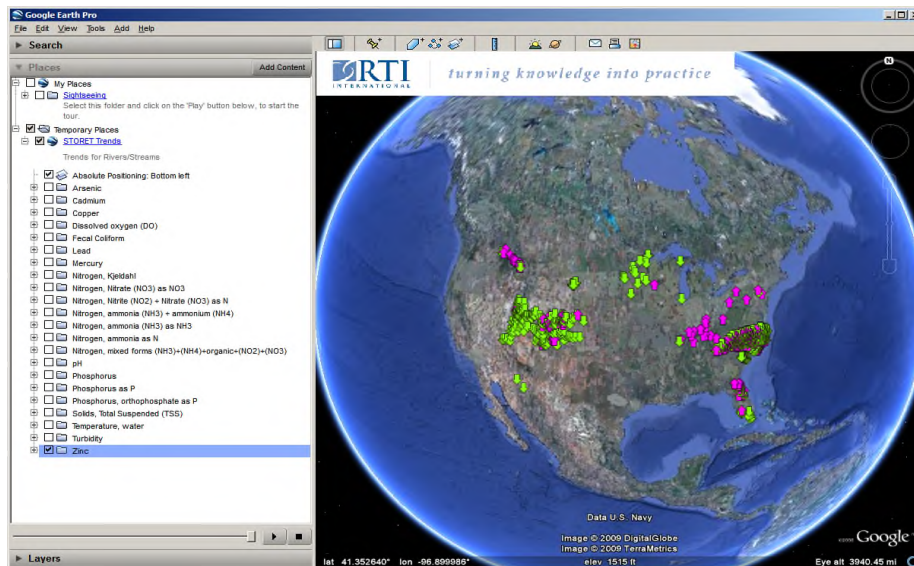


Trend Plot for TSS produced by the STORET Trends Analysis Tool

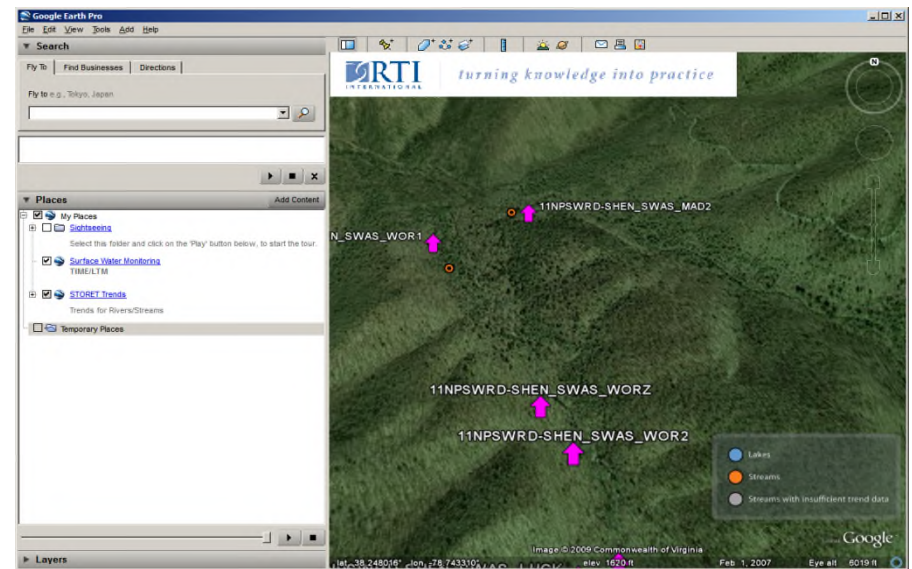


1. STORET Trends Analysis Tool cont.

- Tool produced a Google KML map interface for examining national characteristic trends
- Users can use interface to visualize the trend nationally or drill in on a specific station of interest.



STORET Trends Analysis Tool, National View



STORET Trends Analysis Tool, Drill Down View

2. CWA Reporting Tools

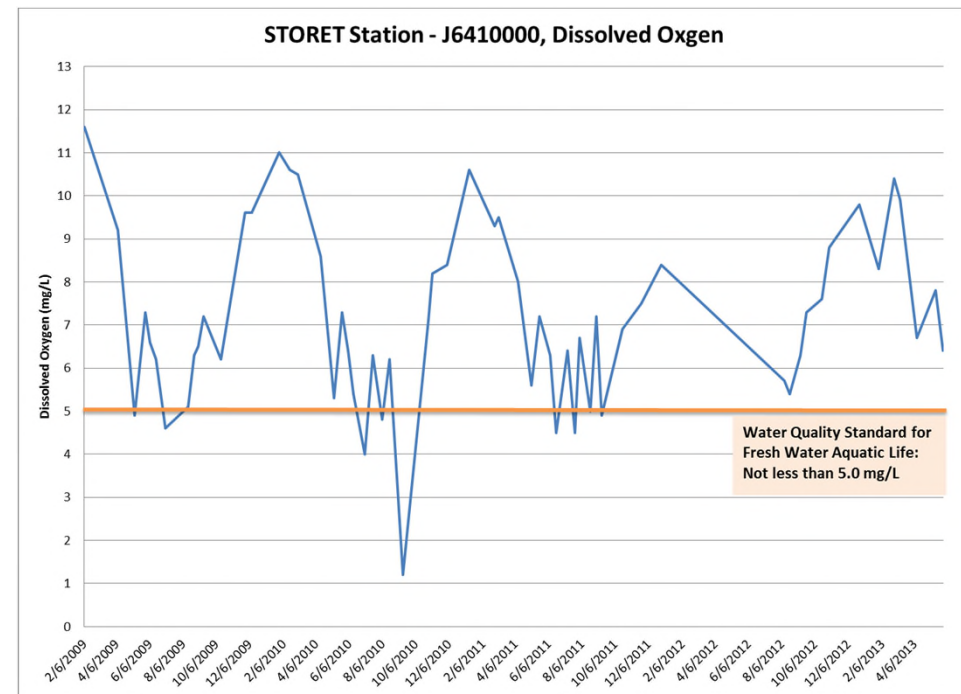
- Compare STORET/NWQ Portal data to a value (e.g., a WQS) for a parameter of interest.
- Tailored to state-specific needs: waterbody-specific water quality criteria and standards.
- Screening exceedances could be flagged, and samples with results of concern could be highlighted to steer a user to particular areas that may have water quality problems.

2. CWA Reporting Tools Cont.



Little Creek (West Side): NC27-86-2-4

Total # of Results	Total # of Exceedences	Min	Max	Average
60	8	1.2	11.6	7.185



3. National Level Screening

- Under CWA 304(a) EPA has established National Criteria to provide guidance for states/tribes to use in adopting Water Quality Standards.
- Create a tool to assist in screening against the national recommended water quality criteria.
- Example: Identify all observations of nitrogen/phosphorus that exceed the ecoregional nutrient criteria.

3. National Level Screening Cont.

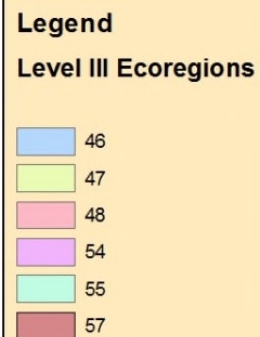
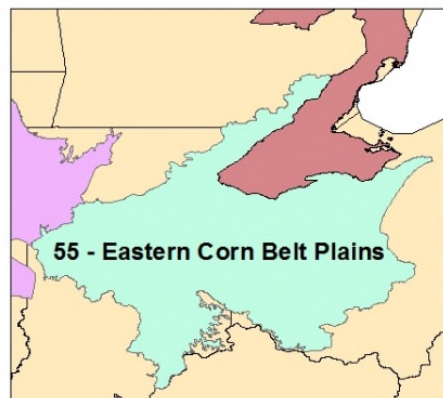
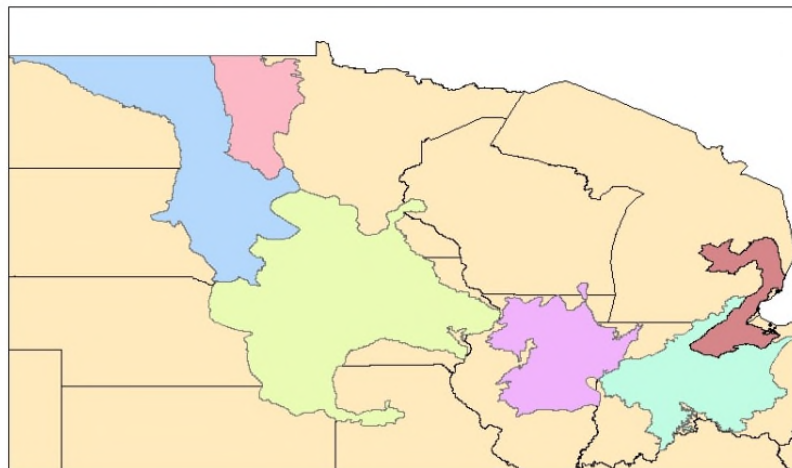
- EPA Developed Ecoregional Criteria for Total Phosphorus, Total Nitrogen, Chlorophyll *a* and Water Clarity.
- For this example Ecoregion VI, #55 *Eastern Corn Belt Plains* was used.

Table 3e. Reference conditions for level III ecoregion 55.

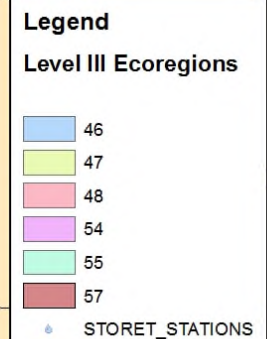
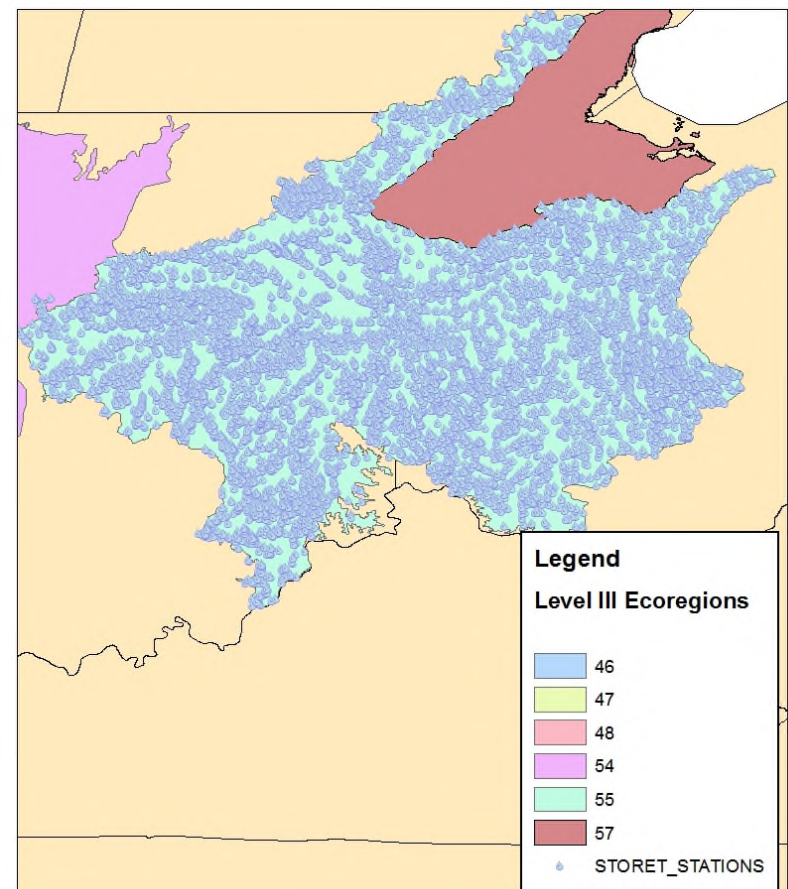
Parameter	No. of Streams N ⁺⁺	Reported values		25 th Percentiles based on all seasons data for the Decade	Reference Streams ⁺⁺
		Min	Max	P25-all seasons ⁺	P75 - all seasons
TKN (mg/L)	198	0.05	3.5	0.4	
NO ₂ + NO ₃ (mg/L)	219	0.025	8.13	1.60	
TN (mg/L) - calculated	NA	0.075	11.63	2	
TN (mg/L) - reported	2 z	3.63	3.78	3.63	
TP (µg/L)	225	10	1820	62.5	
Turbidity (NTU)	1 z	10.4	10.4	10.4 zz	
Turbidity (FTU)	12	3.3	50.65	9.21	
Turbidity (JCU)	1 z	28	28	28 zz	
Chlorophyll <i>a</i> (µg/L) -F	—	—	—	—	
Chlorophyll <i>a</i> (µg/L) -S	8	4.32	19.24	6.62	
Chlorophyll <i>a</i> (µg/L) -T	8	6.67	22.72	7.99	
Periphyton Chl <i>a</i> (mg/m ²)	—	—	—	—	—

3. National Level Screening Cont.

Aggregate Nutrient Ecoregion 6



**Level III Ecoregion - 55: Eastern Corn Belt Plains
River and Stream Monitoring Stations**



3. National Level Screening Cont.

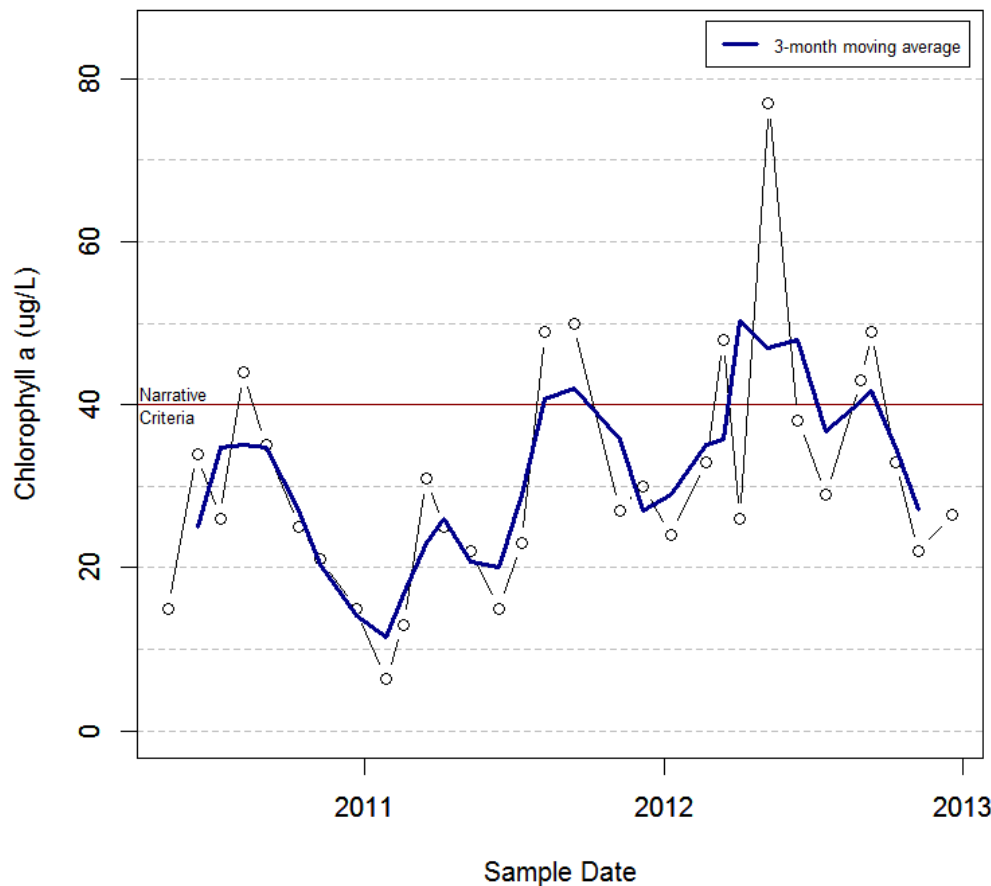
- For this ecoregion there are over 12,000 stations
- Screening Tool would allow user to:
 - Define parameter,
 - Define date range,
 - Select statistics for data (e.g. number of samples that exceed the reference conditions for parameter)
- Screening tool would return results in user defined format (.xls, .csv, etc..)

4. Exploratory Data Analysis

- Exploratory data analysis (EDA)
 - Help identify degrading waters that may need additional protection.
 - Highlight improving waters showing progress towards restoration.
- EDA tools can be used to:
 - Examine parameter trends over time.
 - Identify relationships between parameters and other variables.
 - Estimate the probability of threshold exceedances.
 - Characterize central tendency (mean, median) and variability of parameter values.
 - Compare outputs described above by: station, watershed, county, eco-region, sample month, season, etc.
- Tool outputs can be graphical and/or tabular

4. Exploratory Data Analysis-Time Series Data

Chlorophyll a
Station ID NEU0171B

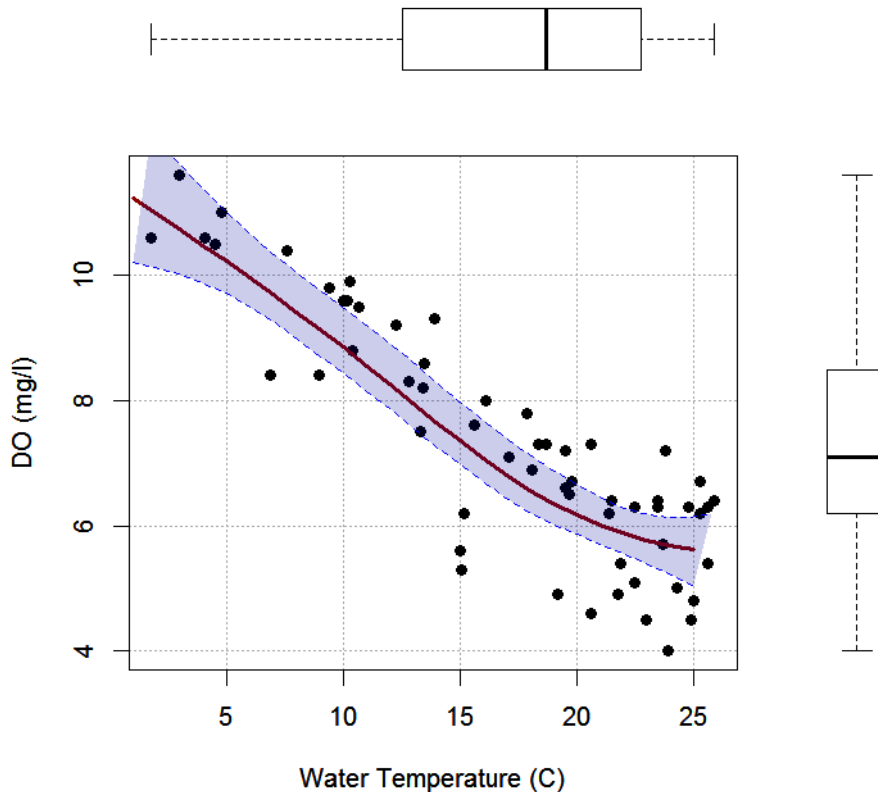


Time series data:

- Identify potential trends over time relative to WQ criteria or other thresholds.
- Add moving average to help clarify trends obscured by noisy (high variability) data.

4. Exploratory Data Analysis- Scatterplots/Trend lines

Relationship between DO and Water Temperature
Station ID J6410000

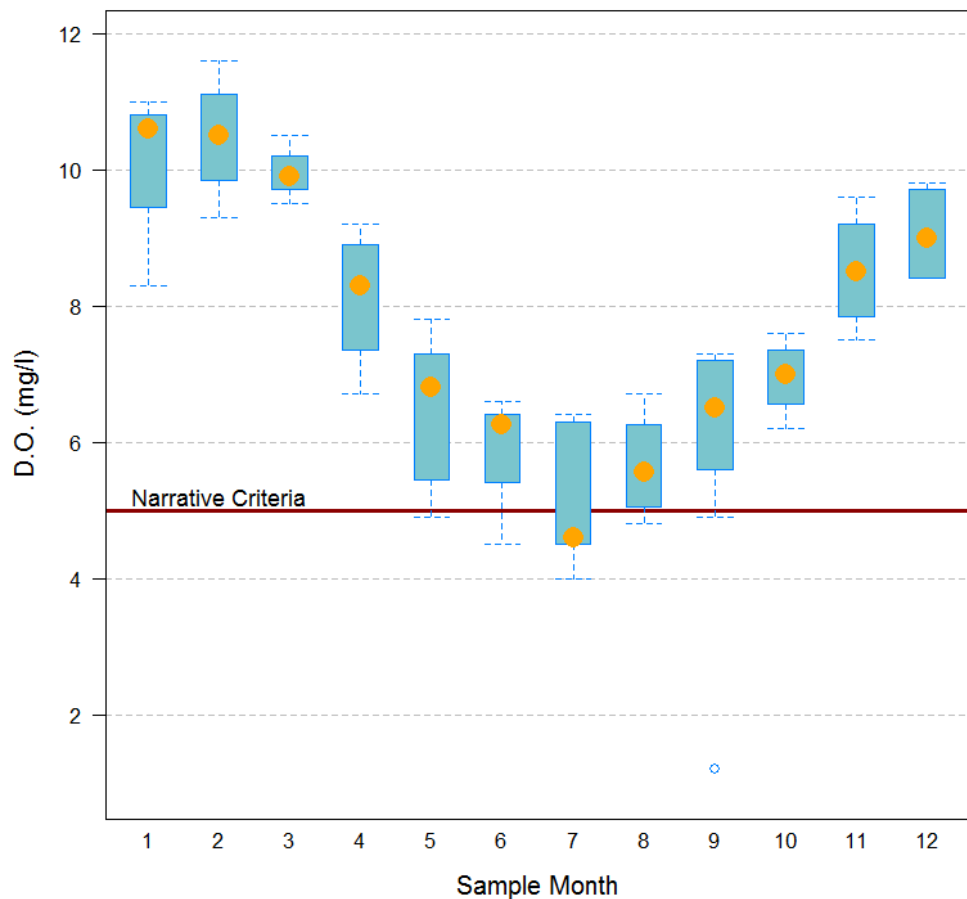


Scatterplots with trend lines:

- Identify the direction, shape, and strength of relationships between variables
- Estimate and display prediction intervals.

4. Exploratory Data Analysis - Boxplots

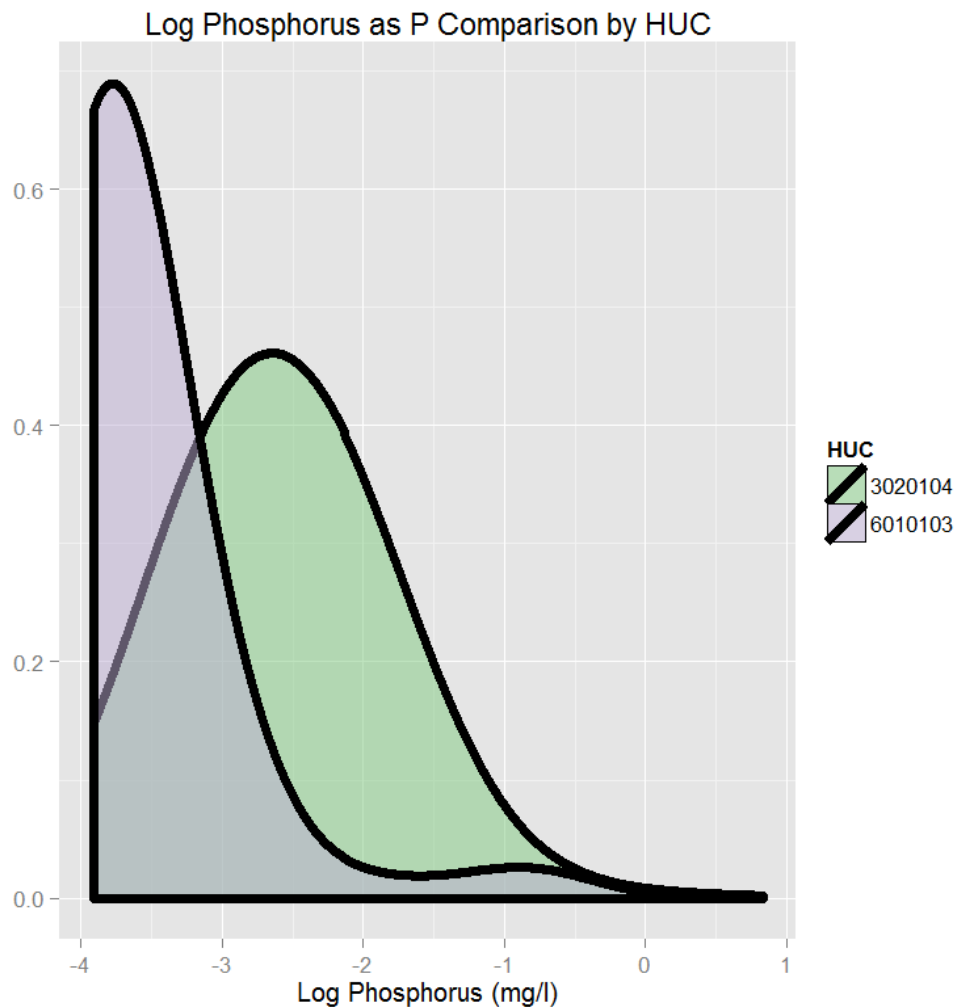
Seasonal Trends in Dissolved Oxygen
Station ID J6410000



Boxplots:

- Show median values, inner quartile range (25th to 75th percentile), outer quartiles and outliers.
- Identify potential spatial or temporal trends.

4. Exploratory Data Analysis– Density Estimates



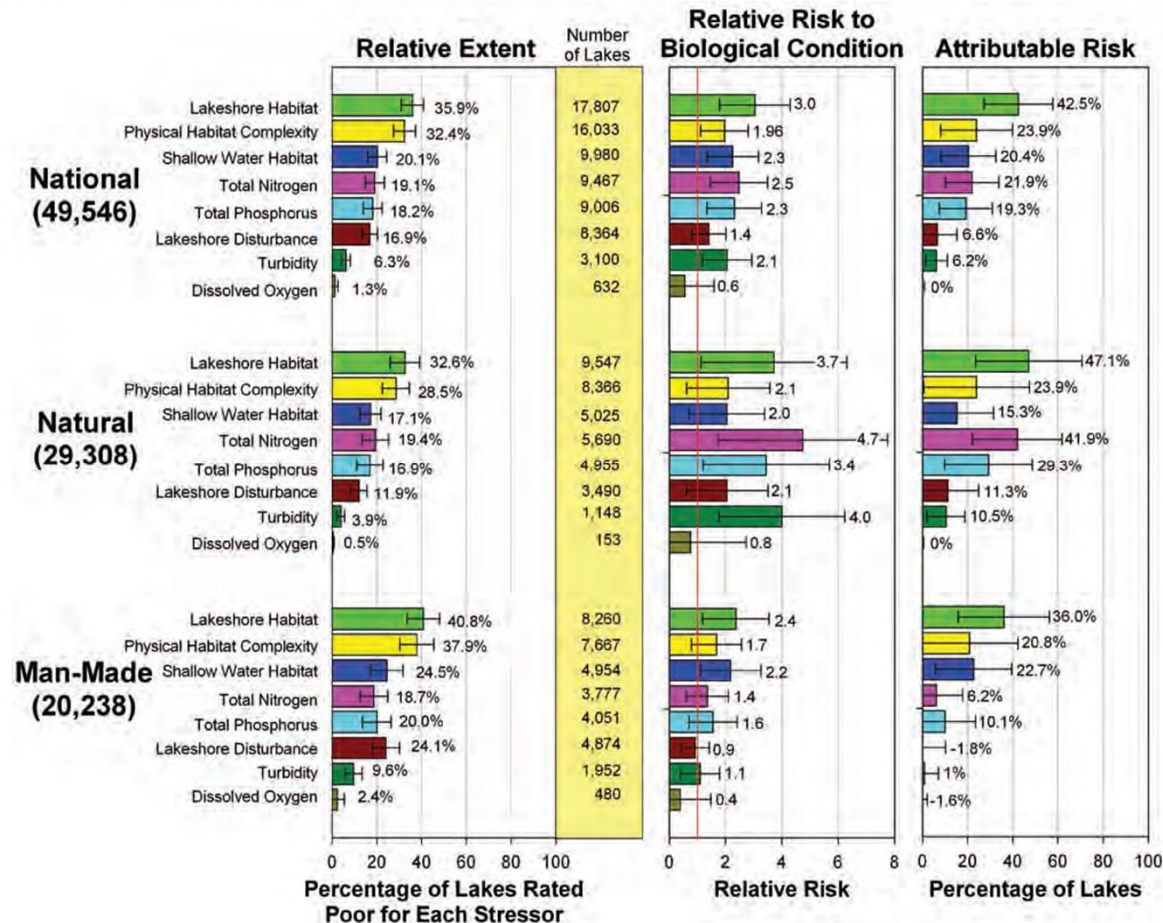
Density plots:

- Display central tendency (mean or median) and spread (variability) of parameter.
- Compare different spatial or temporal units (i.e., is one HUC more likely to experience an exceedance?).
- Identify skewed distributions (i.e., higher probability of extreme values).

5. NARS Tool

- Develop a tool to calculate relative and Attributable Risk for the NARS data set.
 - Relative risk: examines the relationship between a stressor and the response in a measure of biological condition.
 - Attributable risk: builds on relative risk by looking at the likelihood that poor biological condition will exist when stressor levels are rated poor, and at the extent to which those poor conditions exist in the assessed region.

5. NARS Tool



Relative extent, relative risk and attributable risk has been used to assess the condition of the nation's lakes (US EPA, 2009)

Additional Functions

- **Upstream/downstream summarization:** Select a pour point and summarize data upstream. Or once a station is selected, select any other stations with same parameter downstream for X km. Results could be plotted on the same graph(s) for comparison.
- **NHDPlus Catchments:** Report out the NHDPlus catchments associated with monitoring stations.
- **Ecoflows Calculation:** STORET contains biological and habitat data that could be useful for site-specific or cross-sectional ecological flow analysis. (Note: RTI has demonstrated the potential for such cross-sectional analyses using data from North Carolina)

Conclusions

- ✓ A range of nationwide analytical could be developed to access the wealth of data within the STORET Data Warehouse.
- ✓ Streamline the process of compiling relevant information for state users and EPA decision makers.
- ✓ Reinforce interest in the STORET Data Warehouse and bolster the user community's interest in providing data.
- ✓ Utilize Open Source software for development:
 - ✓ Eliminates the costs associated with licensing fees and/or costly updates due to software version changes.
 - ✓ Allows for easier code sharing for customization by jurisdictions.



For More Information

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